



**Developing Countries
and
Hybrid Energy Systems:
A World Bank Perspective**

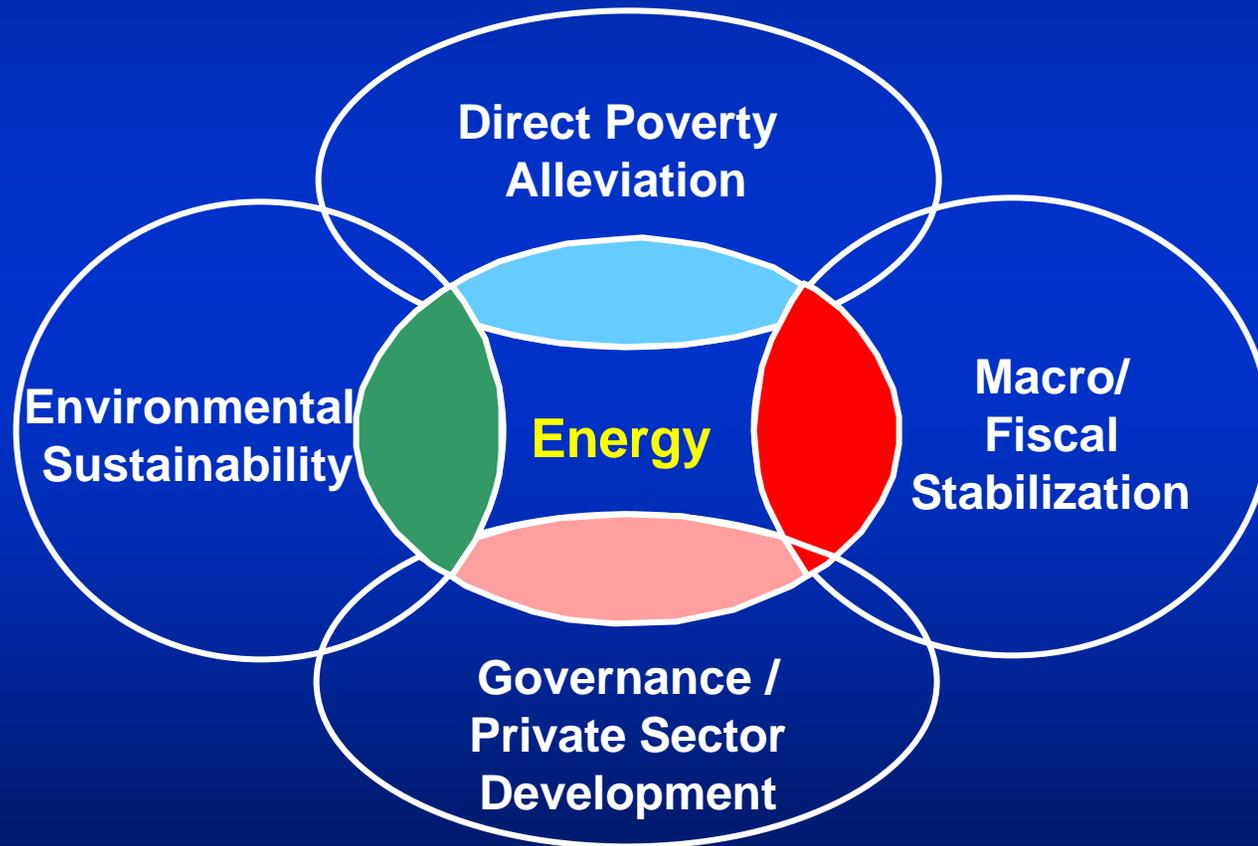
Outline of Presentation

- ✍ Energy Situation in the Developing World
- ✍ Market Driver #1 – Direct Poverty Alleviation
- ✍ Market Driver #2 – Environmental Sustainability
- ✍ Hybrid Systems in the World Bank's Portfolio
 - Solar Thermal/CCGT Hybrids
 - Grid-Connected Wind/Diesel Hybrids
 - Off-Grid Wind/Diesel/PV Hybrids
- ✍ Special Sources of Financing
 - GEF
 - Kyoto Protocol Mechanisms

Current Status of Energy in Developing Countries

- ✍ 1.6 billion people don't consume any electricity (& very little LPG or kerosene)
- ✍ Only 15% large cities have acceptable air quality
- ✍ Only 25% of countries have majority private ownership and financing
- ✍ Only 35% of countries have good regulation
- ✍ Only 15% of countries in which industry has choice of supplier

A New Bank Energy Business Strategy Framework

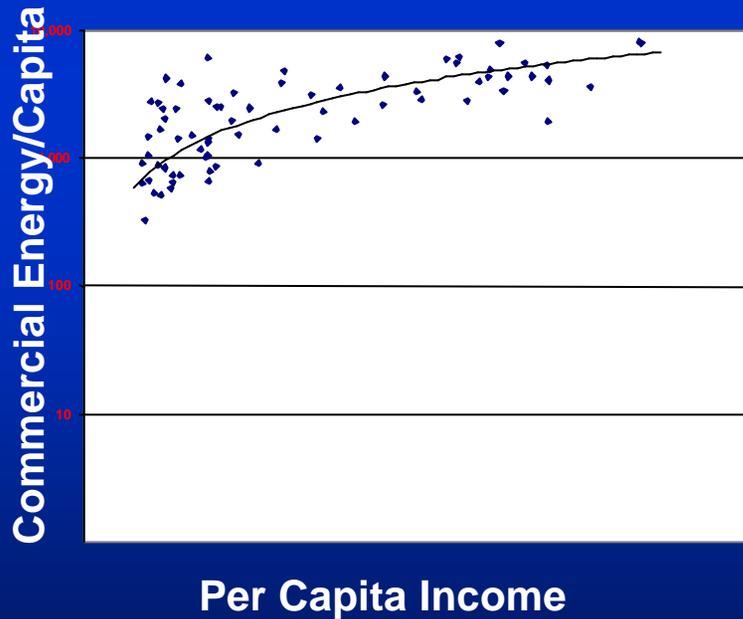


Market Drivers for Hybrid Systems

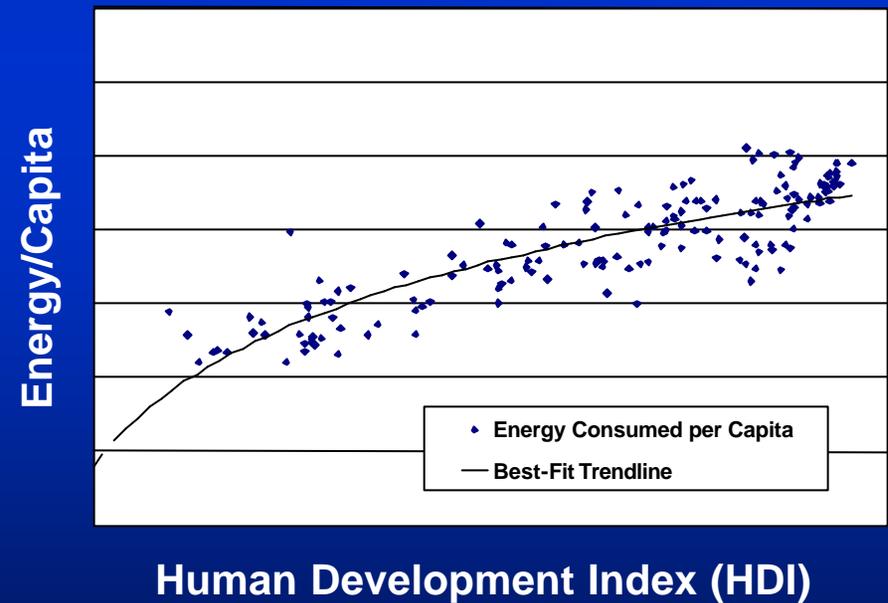
The Poverty/Modern Energy Access
Dimension

Energy-Poverty Linkages: The Macro Picture

Energy and Economic Growth



Energy and Human Development



Meeting the unserved demand is an enormous challenge...

~2 billion people
without access to
reliable and
affordable
modern energy
services

✍ **To meet minimum
needs (*WEC:*
500kWh/year/person),
100 million people
should be connected a
year for the next 20
years as compared to 40
million over past 20
years.**

A changing institutional landscape...

From:

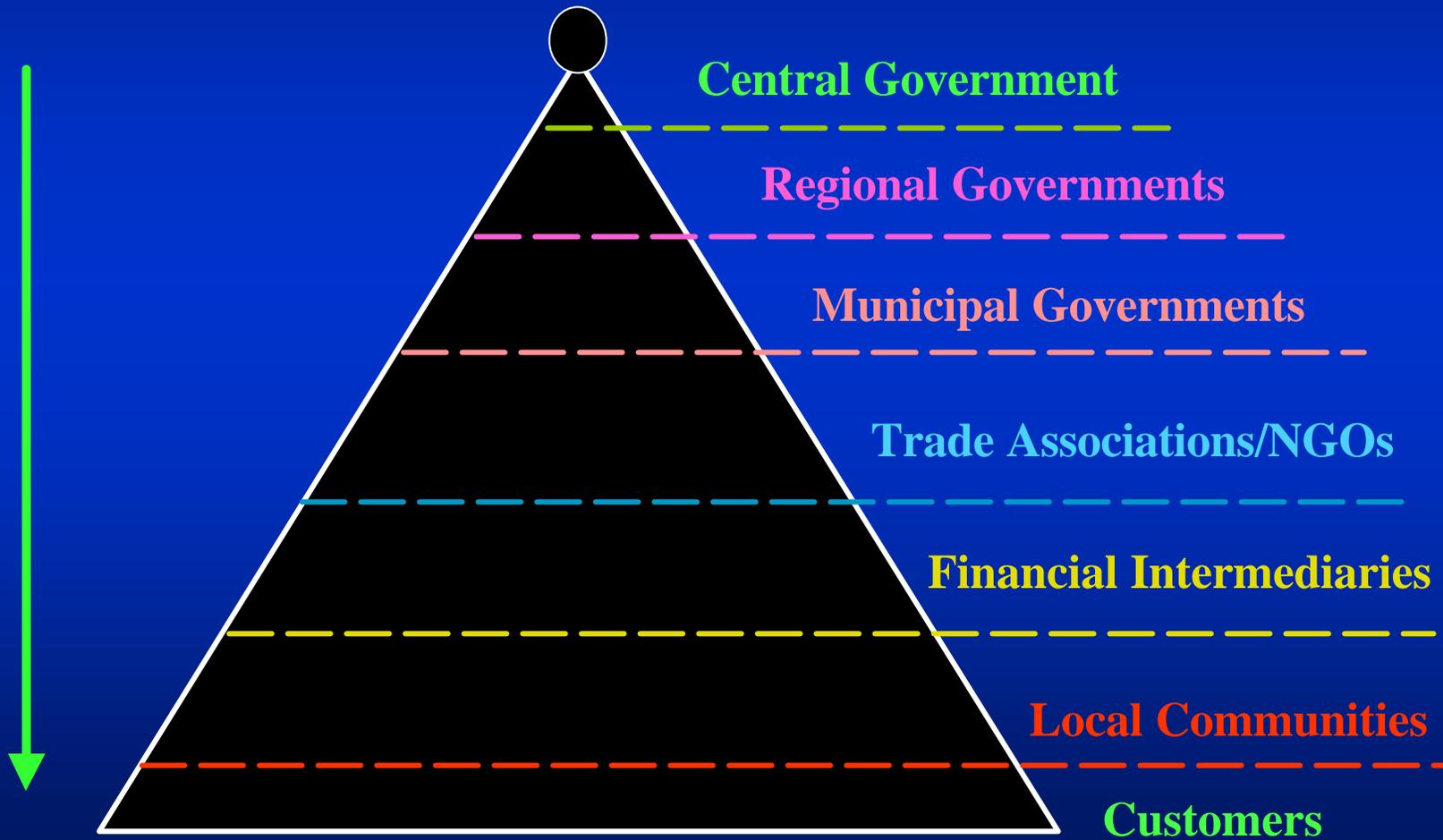


To:

**Monolithic Provider of
“Public Service” under
Social & Environment
Constraints**

**Decentralized, Customer-
oriented Service Business
in New Market Niches**

...and new clients



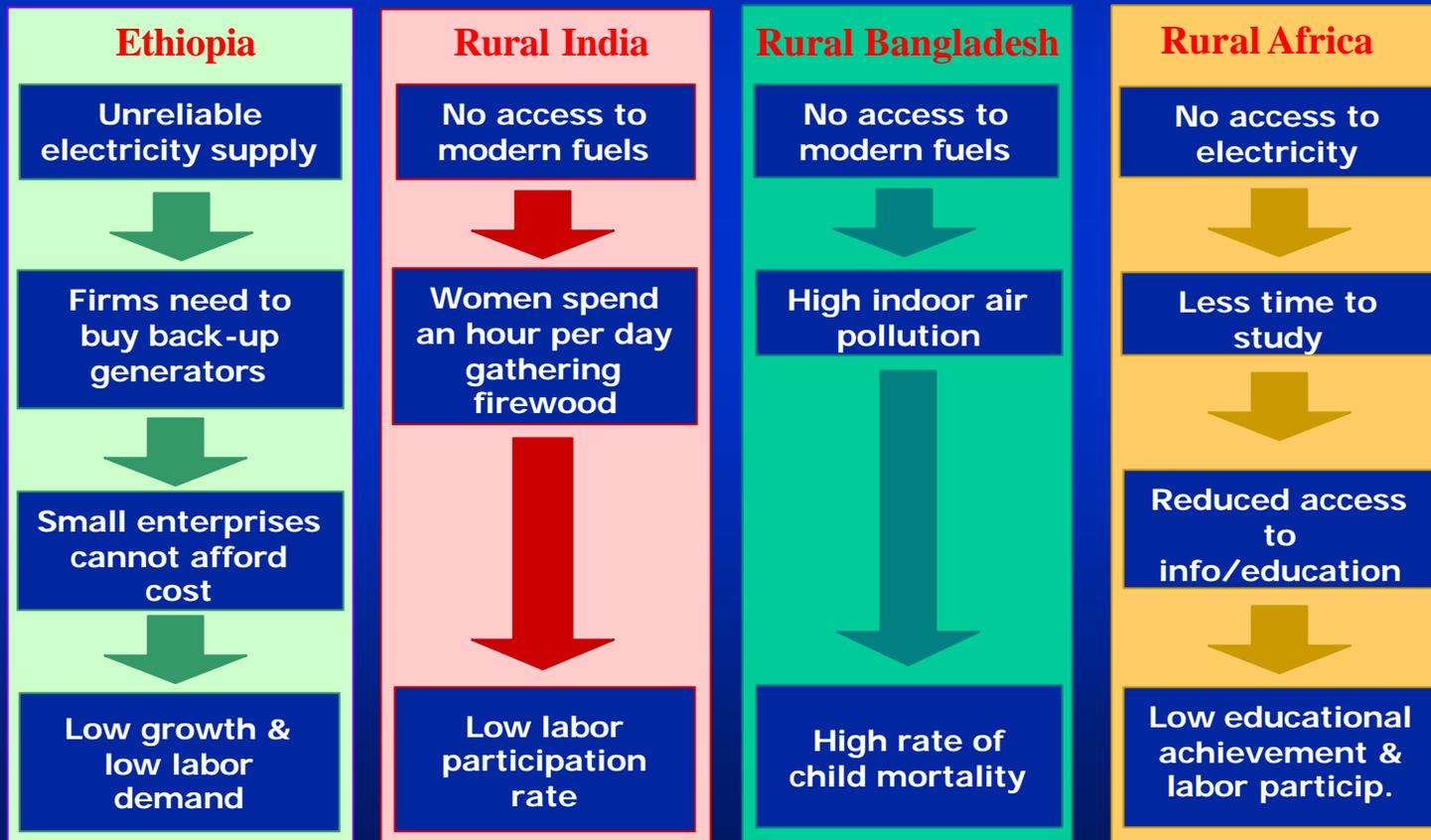
Energy-Poverty Linkages: The Micro Picture

*Enterprise
Productivity*

*Human
Productivity*

Health

Education

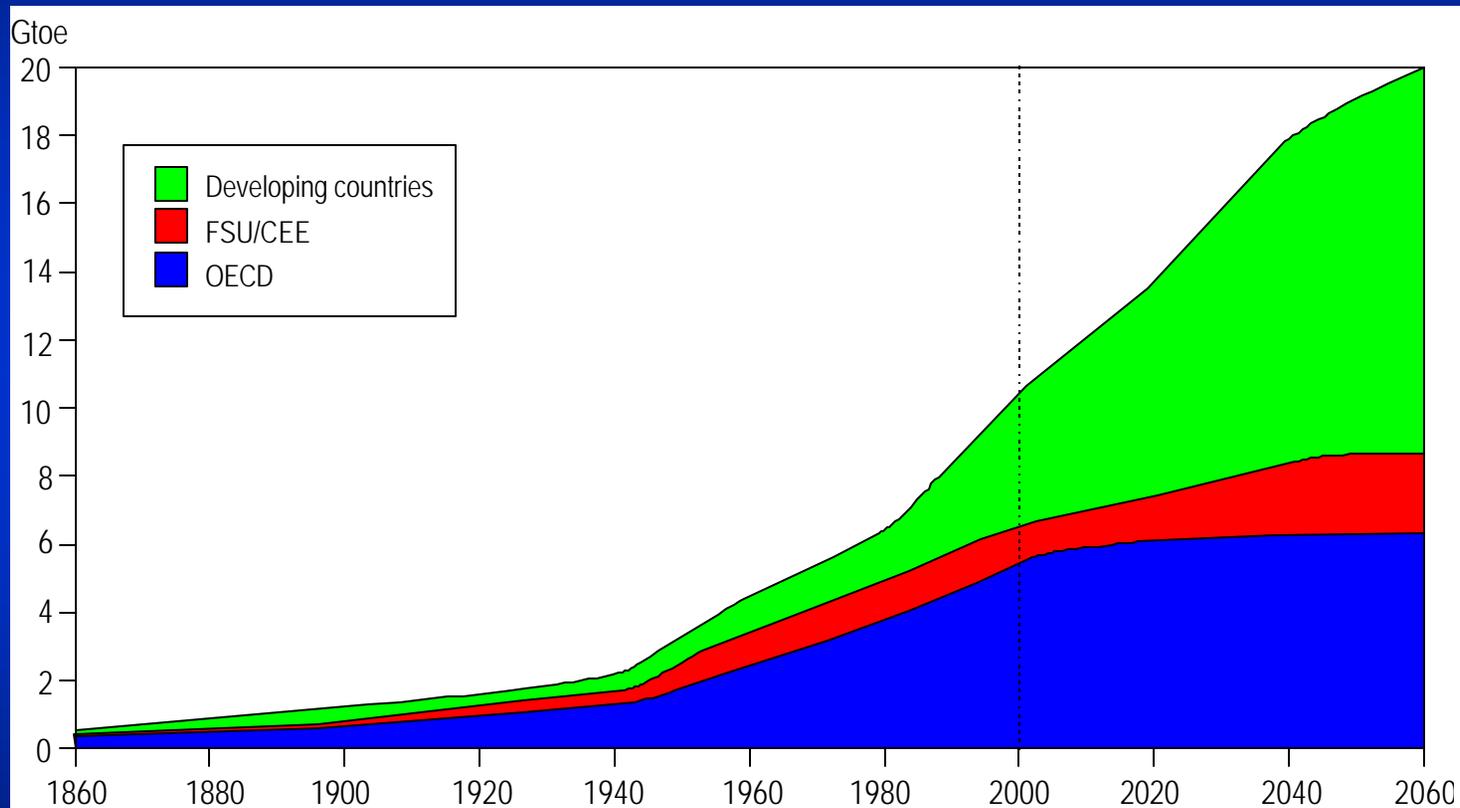




Market Drivers for Hybrid Systems

The Environmental Dimension

How much energy will the world need?

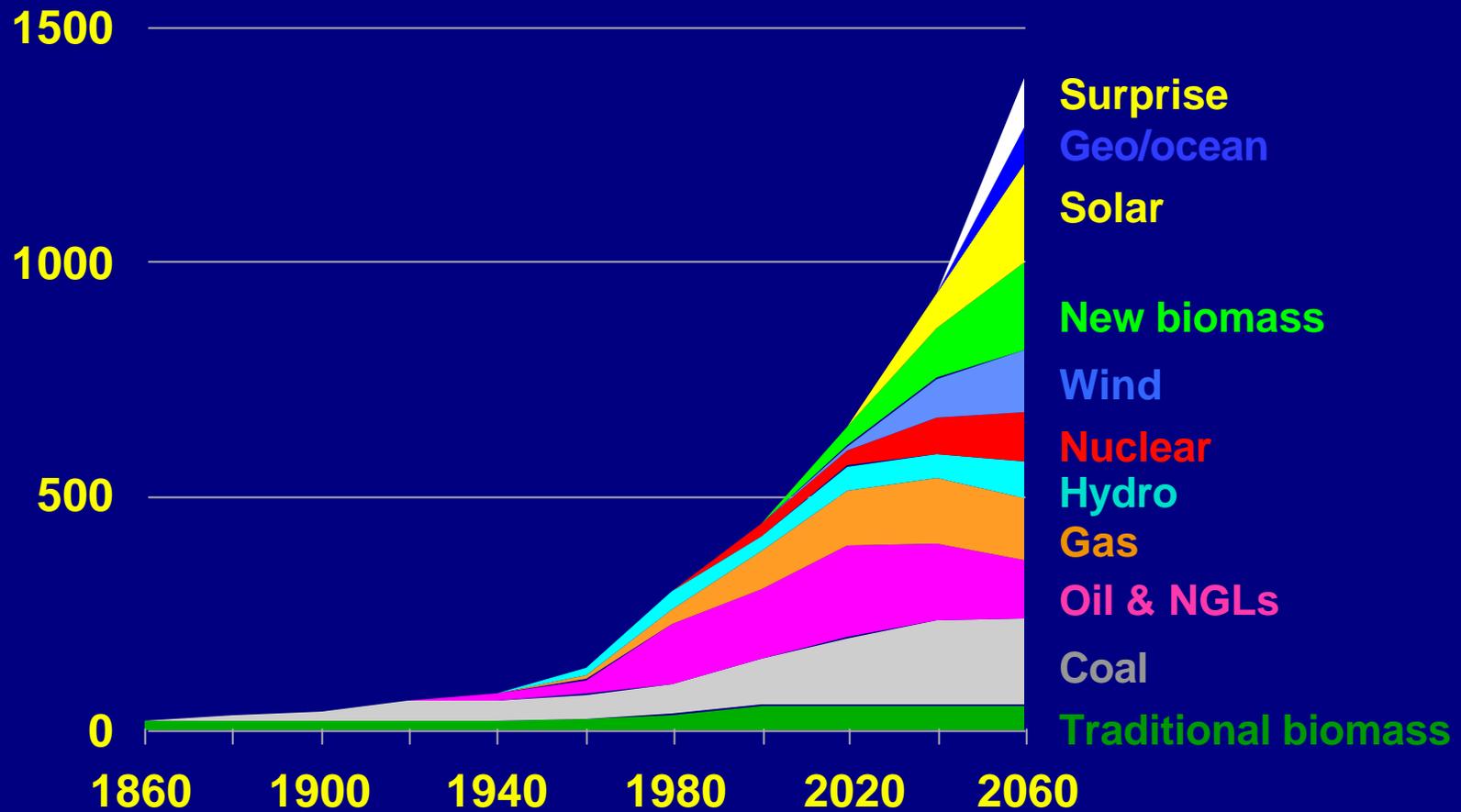


Source: World Energy Council, World Bank.

The graph for the period 2000-2060 shows a scenario of future energy consumption based on current trends.

The Coming Energy Transition

Energy supply, exajoules



Source: Royal Dutch Shell Group

Transition Messages

- ✍ Strong growth, even with efficiency
- ✍ Renewable energy gains market share
- ✍ But. Fossil fuels will be with us for a long time

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Mandate for clean fuels and technologies

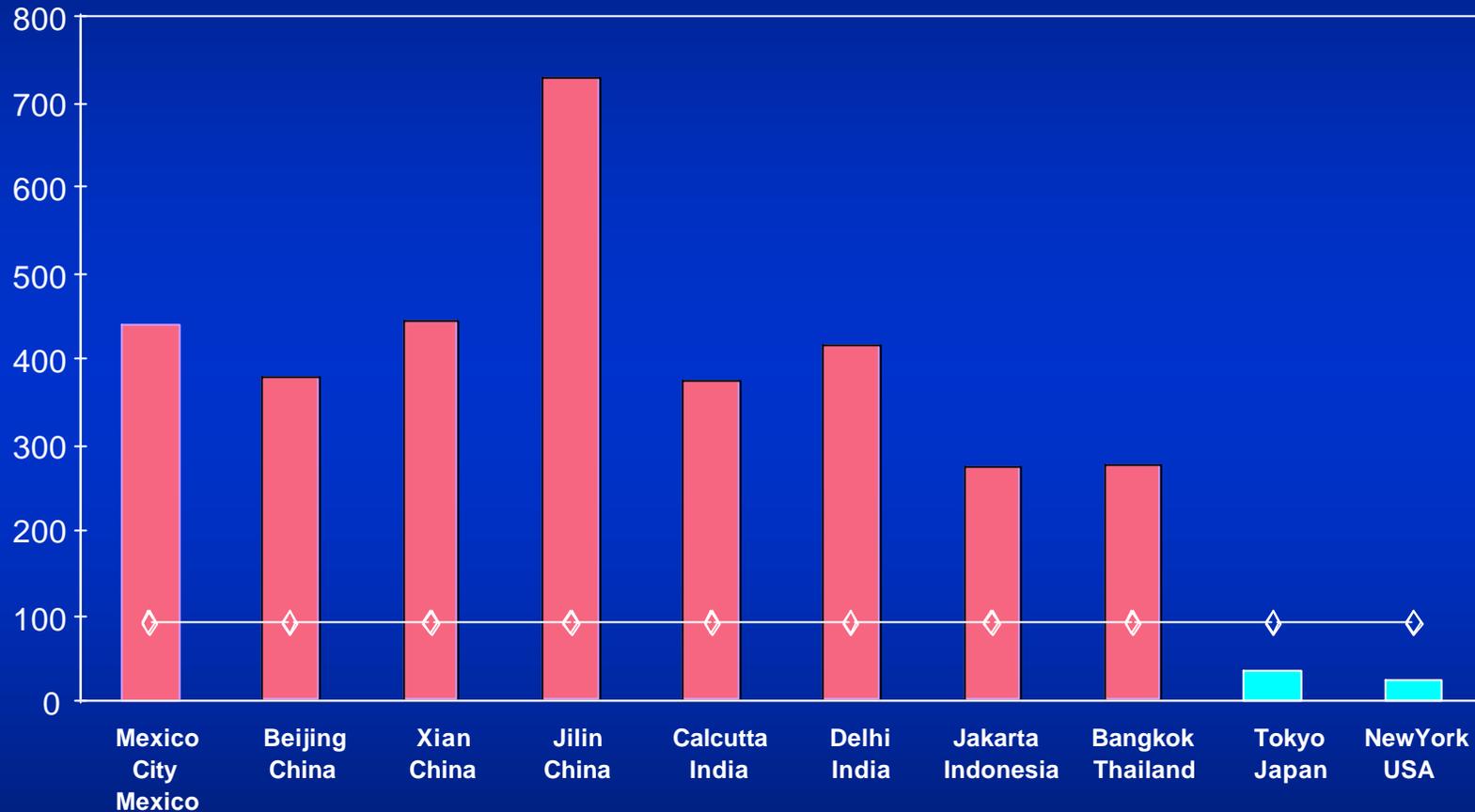


Indoor Air Pollution

- ✍ *India:* 500,000 annual deaths, mainly among children under 5 and women, or 8 % of all deaths in this group
- ✍ *World:* 2 million excess deaths per year, or 5 % of the global burden of disease
- ✍ A leading cause of death and illness: larger than tuberculosis, AIDS, or malaria (WHO, 1996)

Urban Air Pollution (TSP)

annual mean concentration, ug/m³

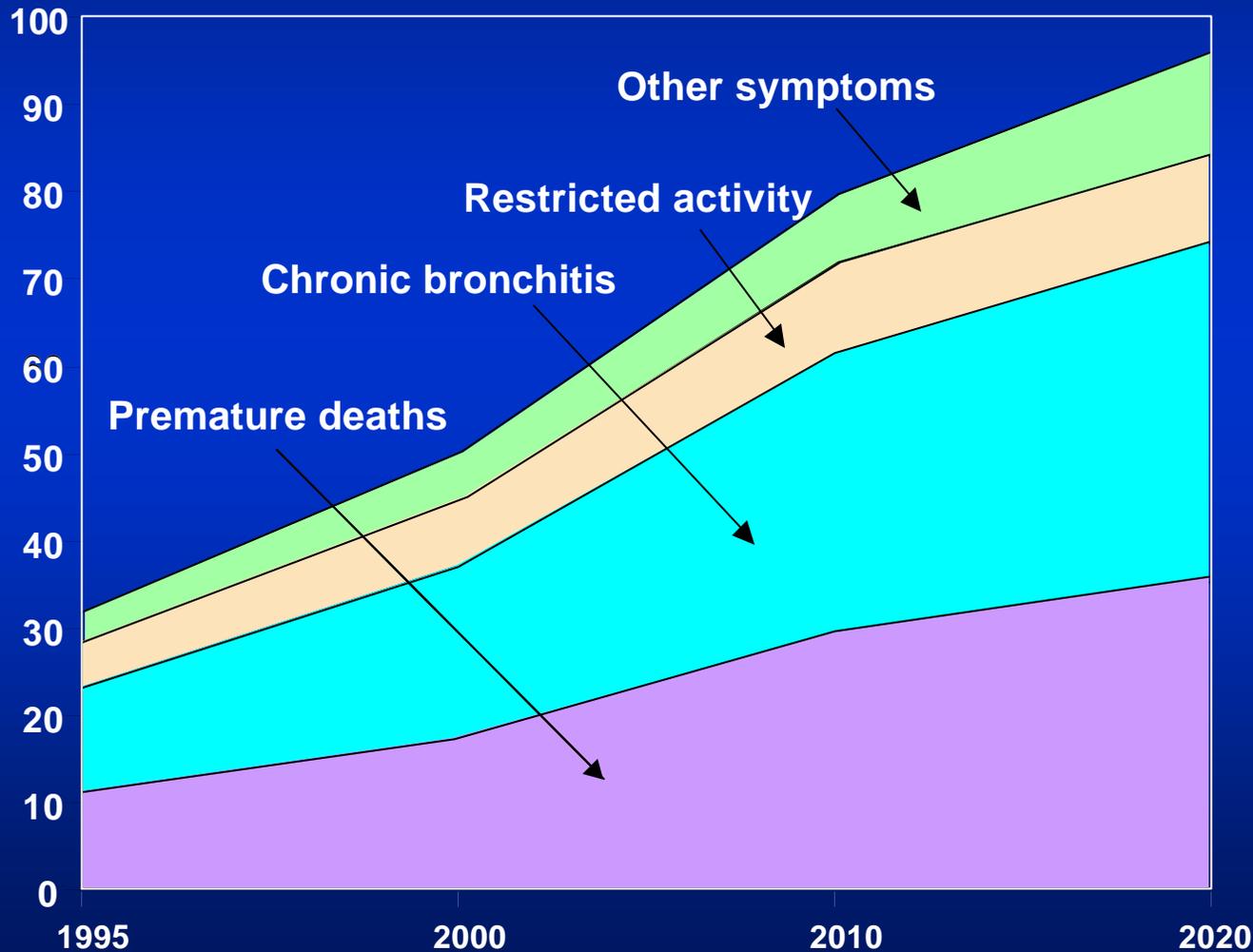


◆ — ◆ **WHO Guidelines**

Source: OECD Environmental data 1995, WRI China tables 1995, Central Pollution Control Board, Delhi. "Ambient Air Quality database. Status and Statistics, 1993 and 1994", Urban Air Pollution in Megacities of the World, WHO/UNEP, 1992, EPA, AIRS

Health Costs of Air Pollution (Annual, TSP in China)

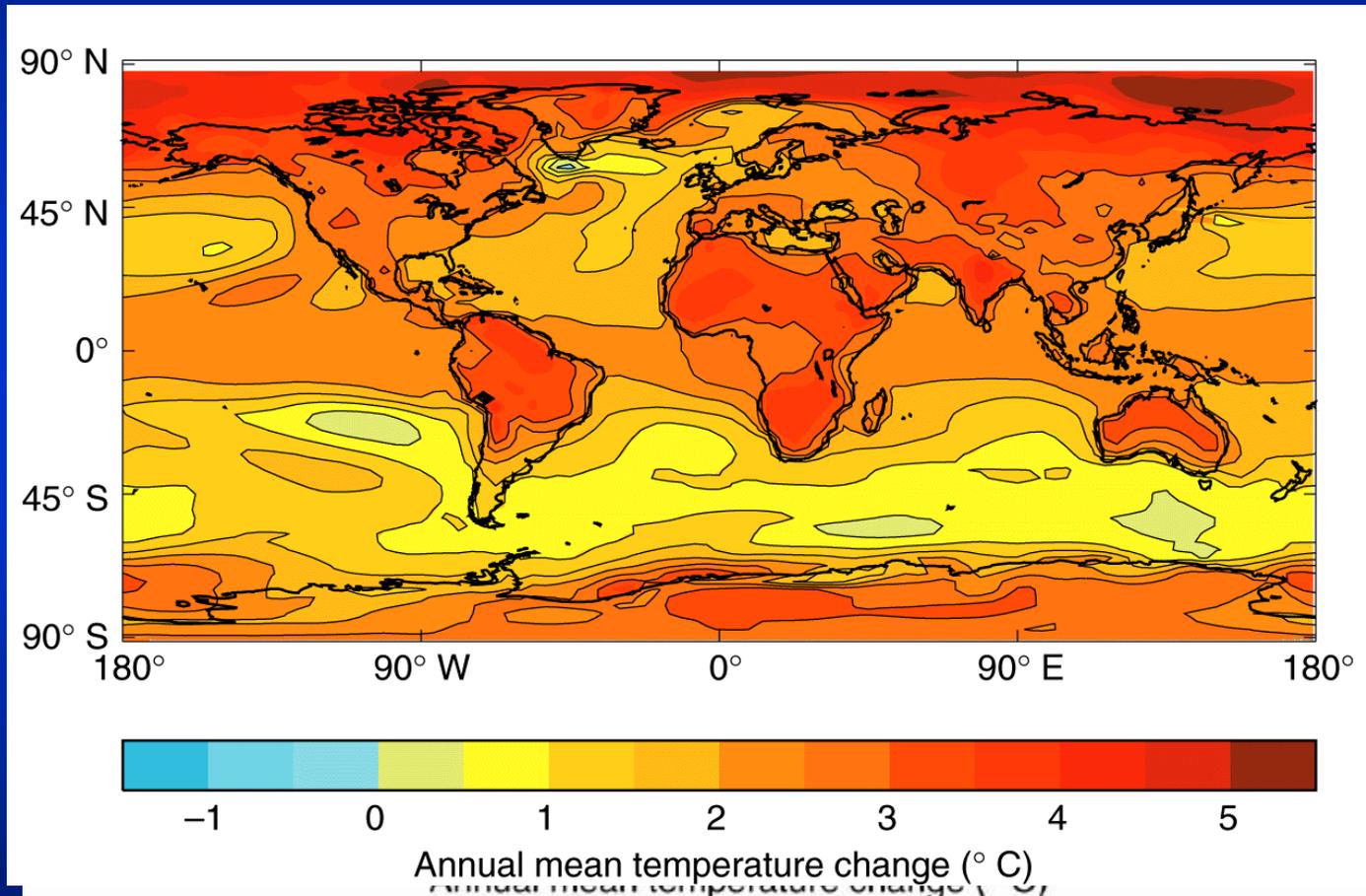
Billions of 1995 US dollars



Source: Clear Water, Blue Skies; China's Environment in the New Century, World Bank, 1997.

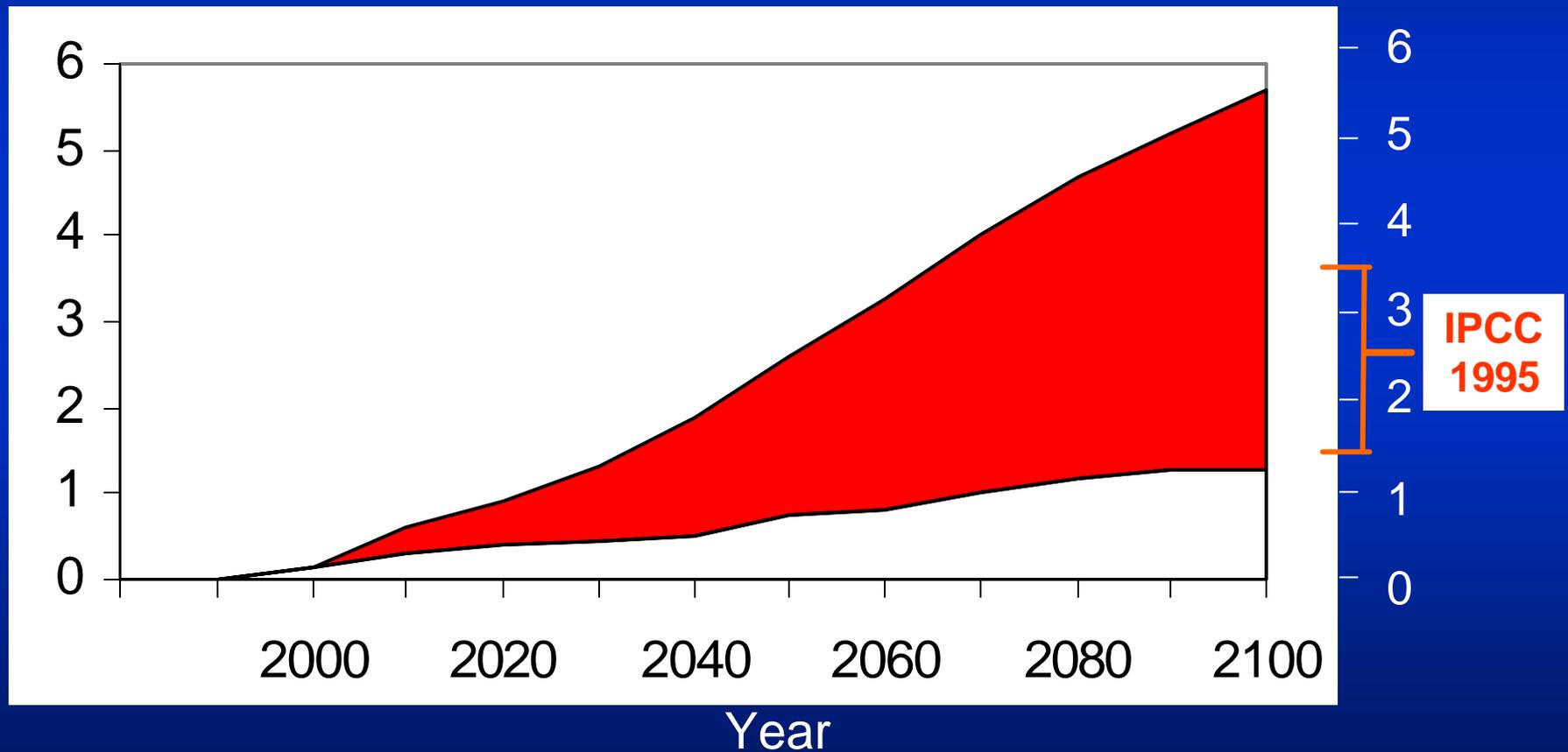
Global Warming

Projected Temperature Change in the 2050s



The change in annual temperatures for the 2050s compared with the present day, when the climate model is driven with an increase in greenhouse gas concentrations equivalent to about a 1% increase per year in CO₂.

Projected Temperature Change IPCC 2000



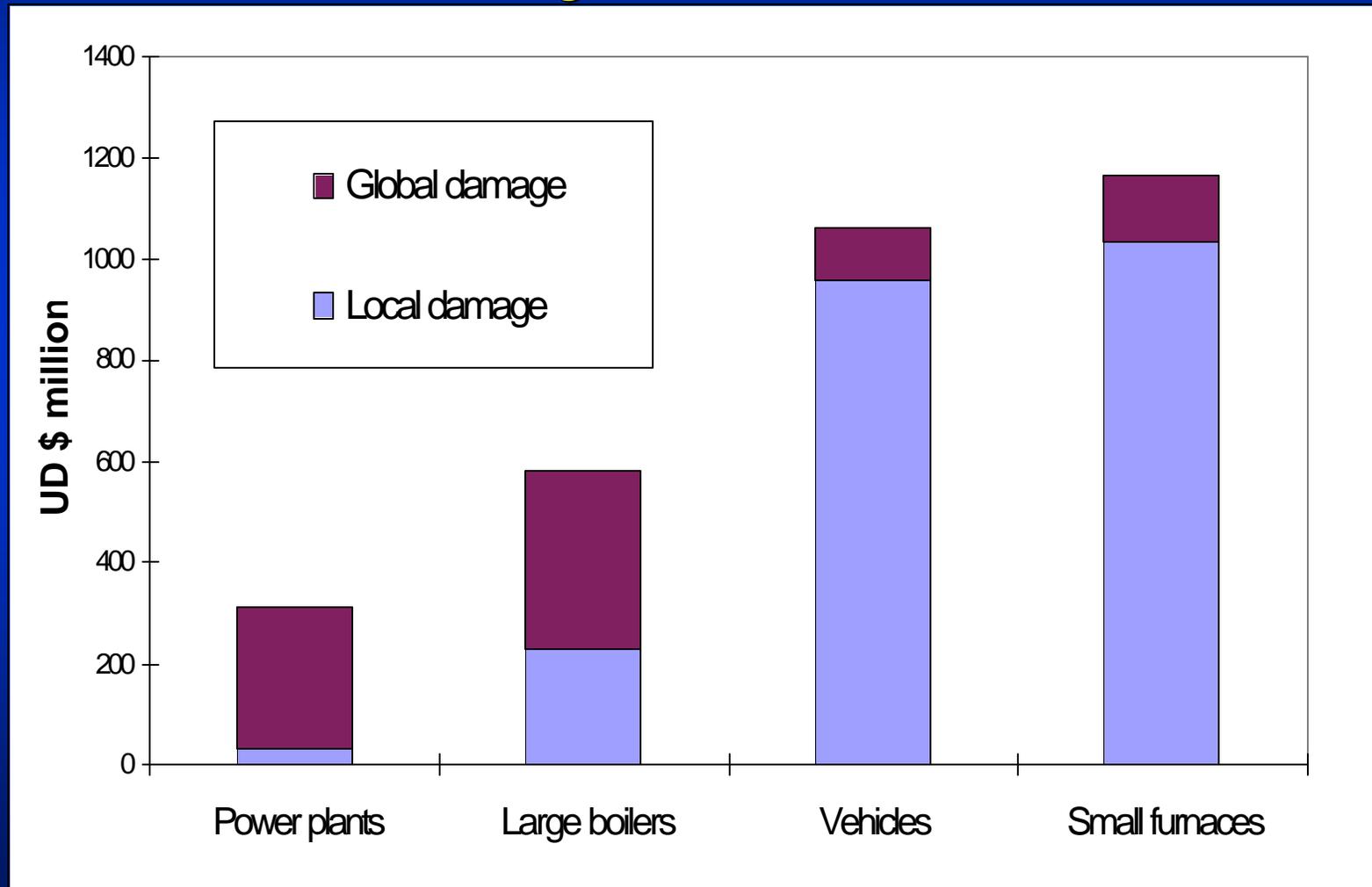
“Continued global warming is in nobody’s interest, but the simple facts of the matter are that developing countries will suffer the most damage, and their poor will be at an even greater disadvantage.

***James Wolfensohn
UNGASS
June 1997***

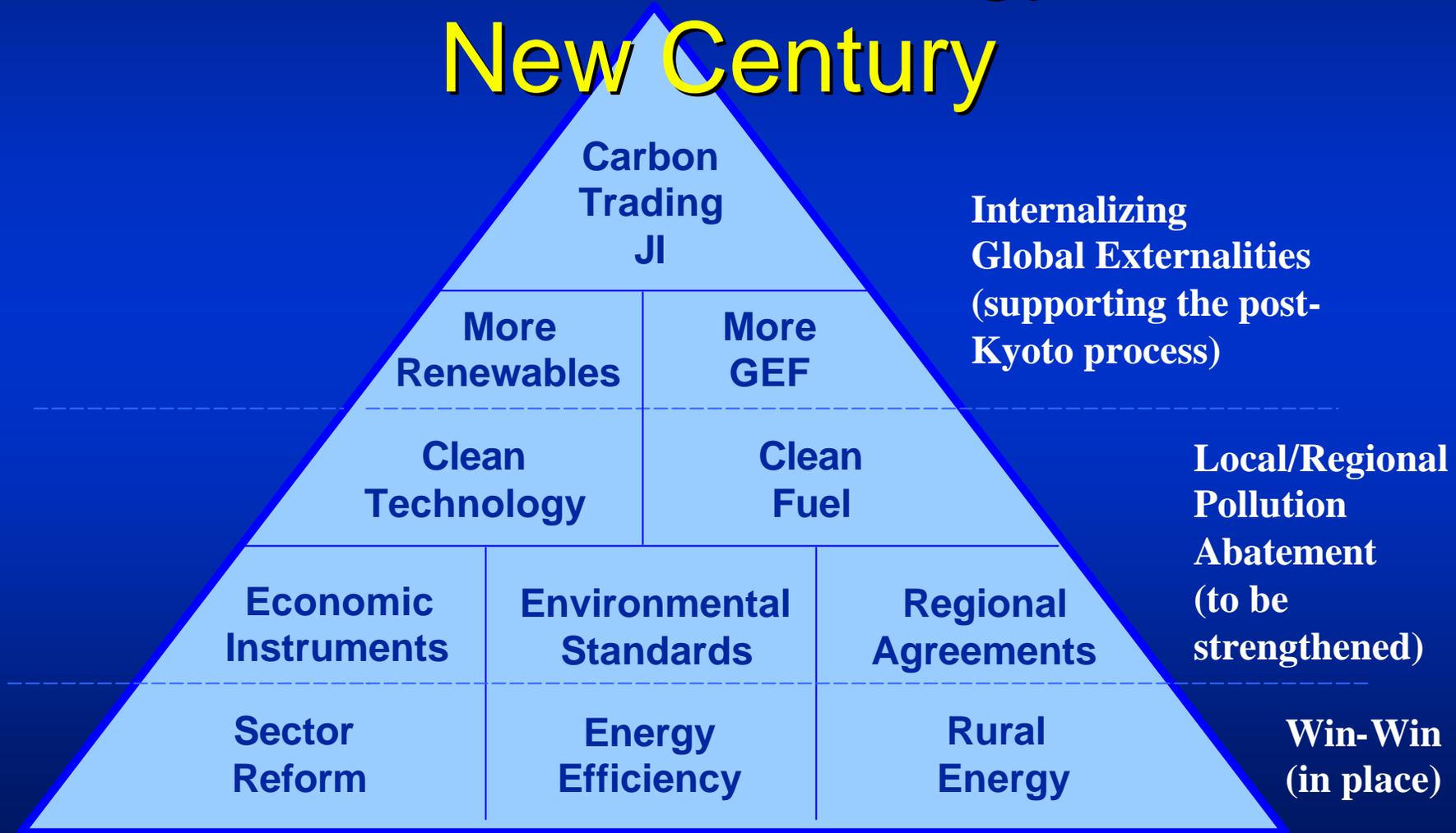


Contribution to local and global damages

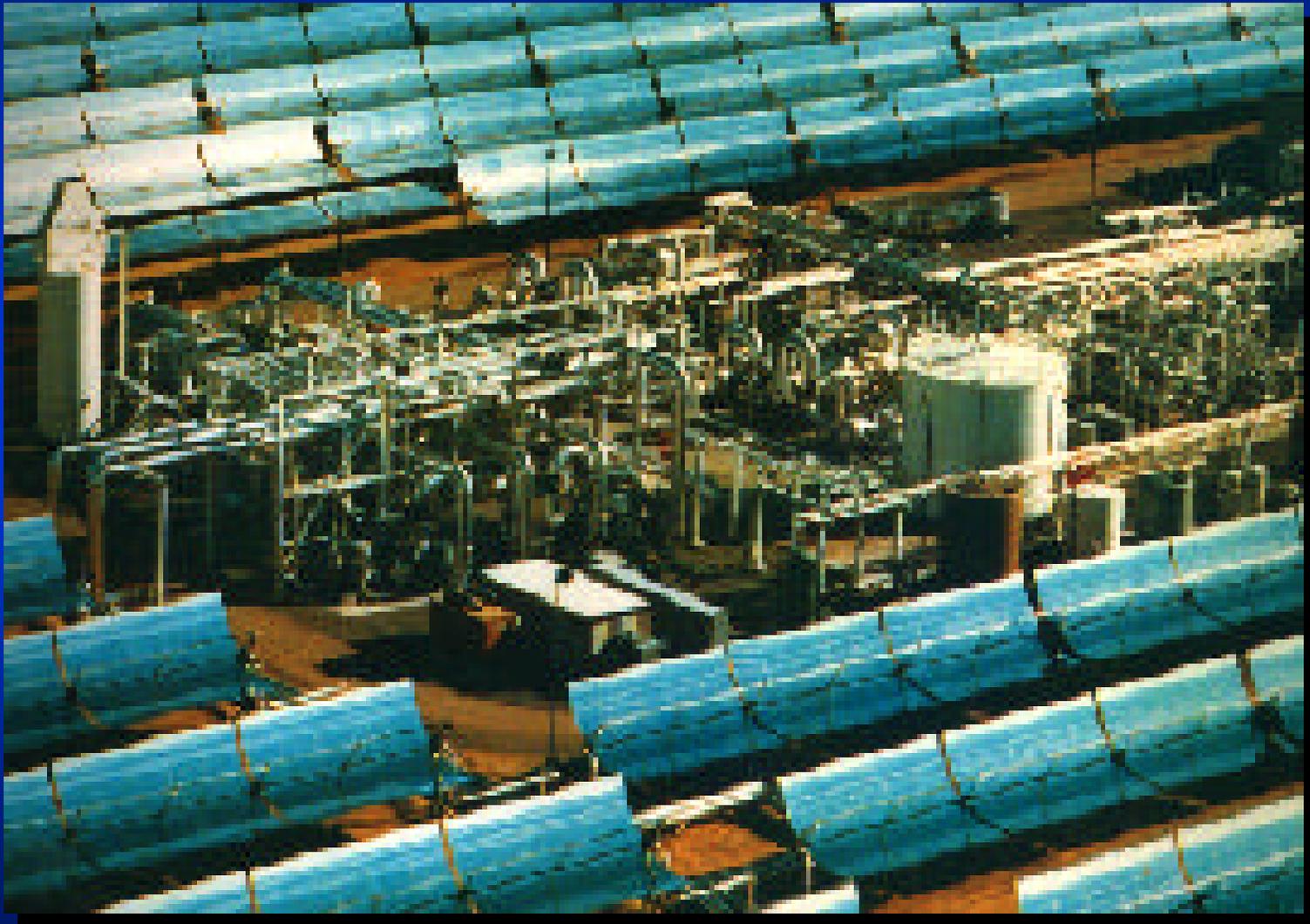
Average for six cities



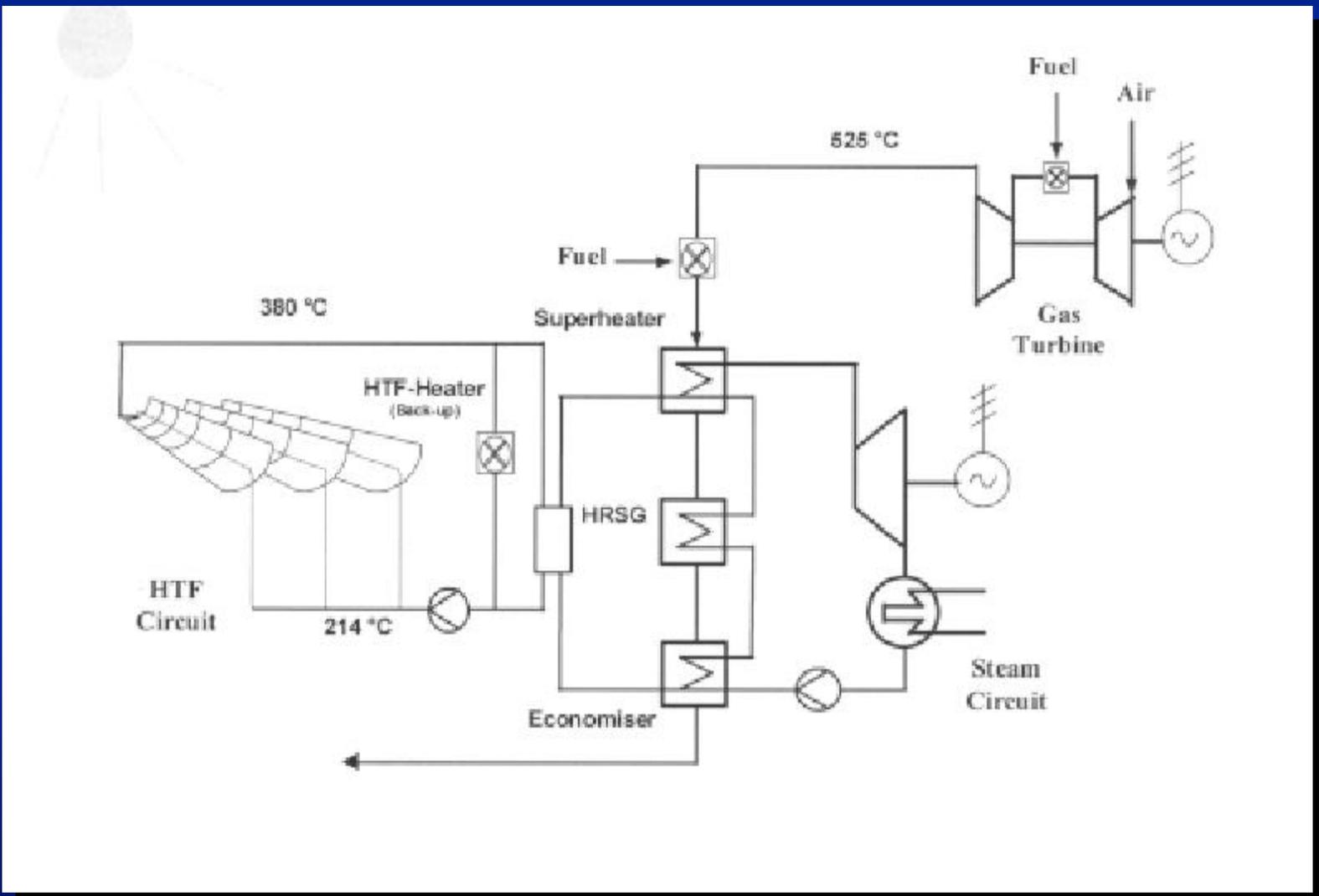
Fuel For Thought: Environmental Strategy for the New Century



Solar Thermal-Electric Hybrids



Integrated Solar Combined Cycle

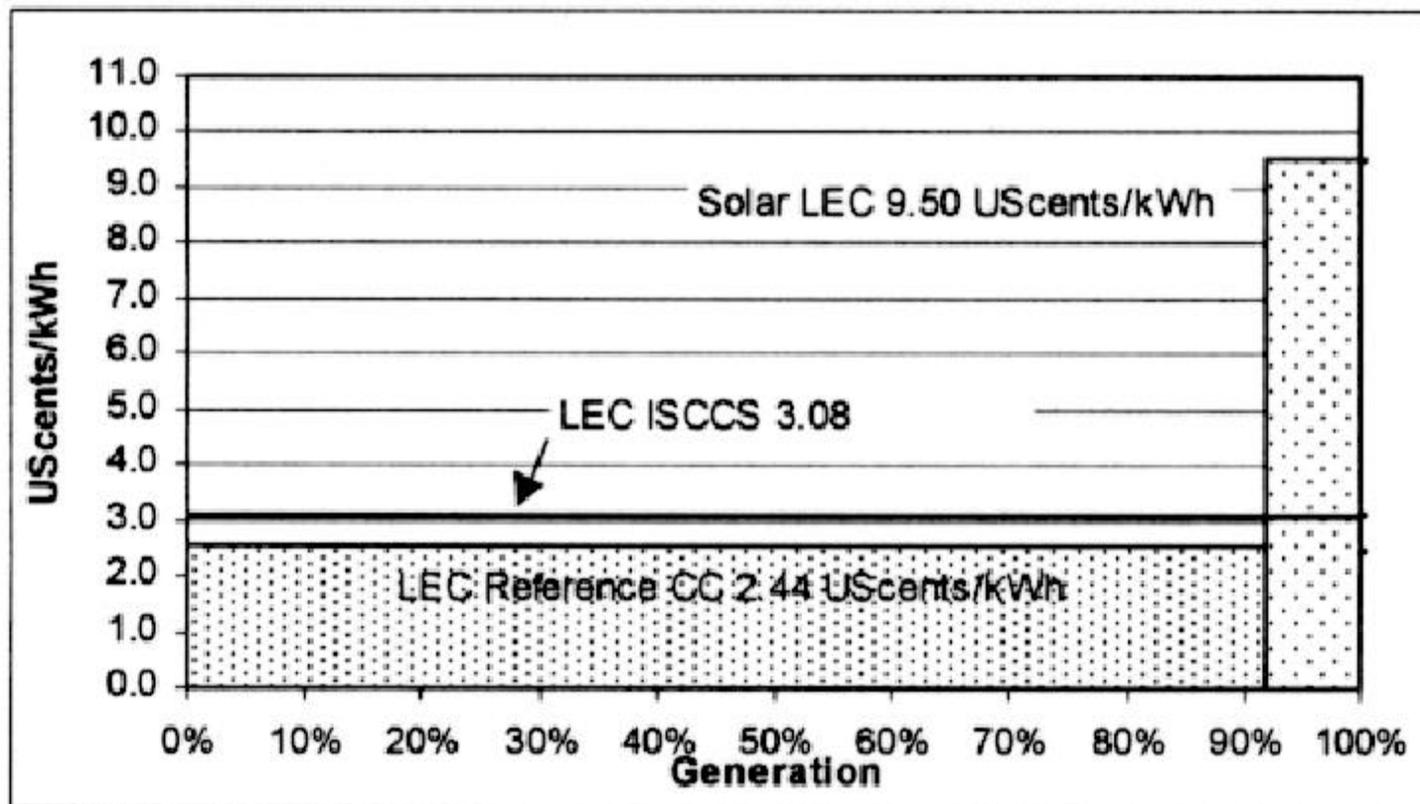


World Bank/GEF ISCCS Portfolio

- ✍ Projects planned for India, Mexico, Morocco, Egypt
- ✍ Typical project financing:
 - \$250 million total cost
 - of which \$50 million GEF grant
- ✍ Solar field = 30-40 MWe
- ✍ Open specification international bid

ISCCS Economic Performance

ISCCS with HTF-Trough



Grid Connected Wind-Diesel Hybrids



Cape Verde Wind-Diesel Grid

✍ Existing grid =

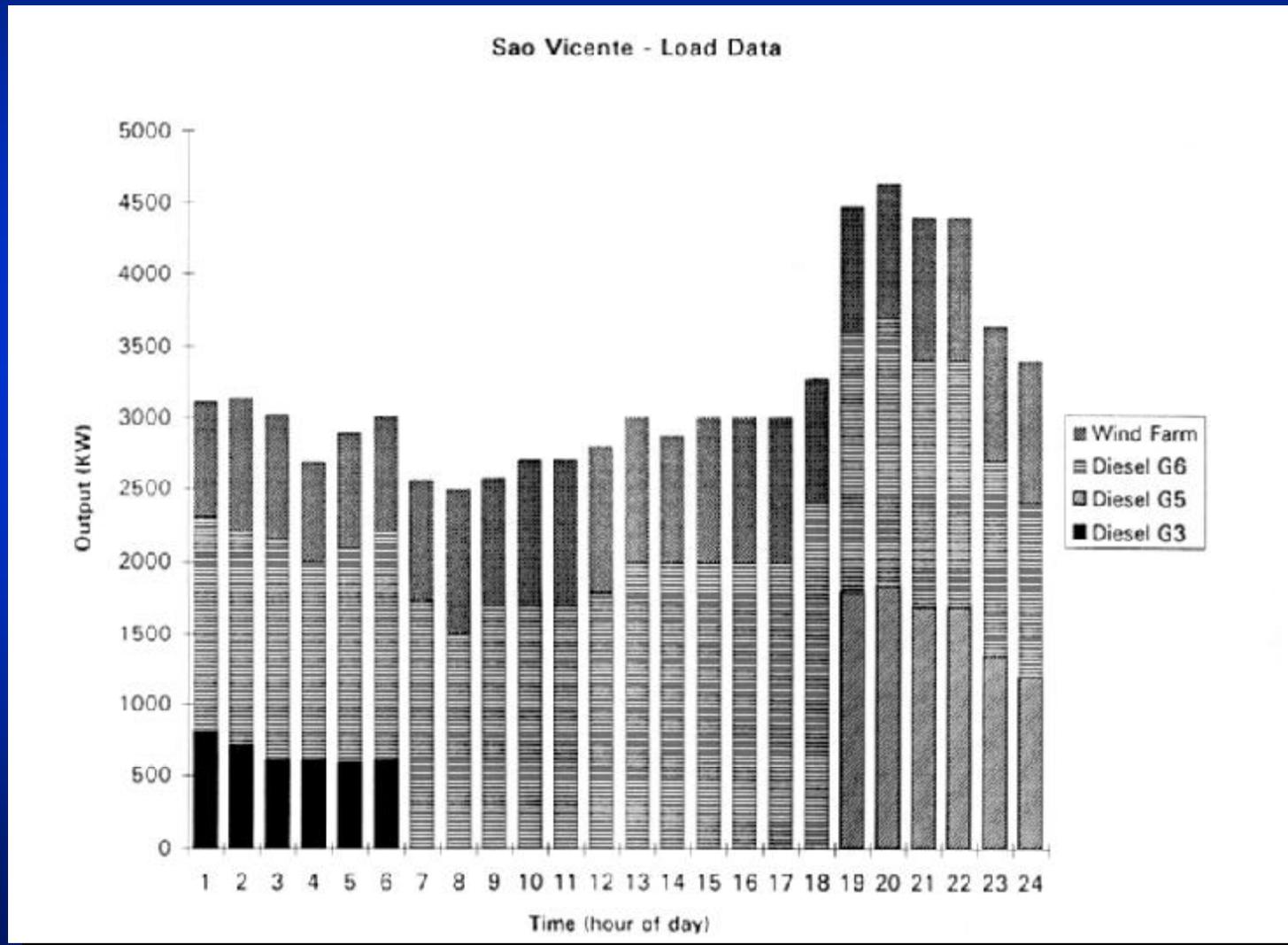
– 35 MW diesel

– 2.6 MW wind

Over three islands

✍ World Bank/GEF project adds additional
7.8 MW at a cost of \$9.0 million

Wind Integration on Diesel Grid



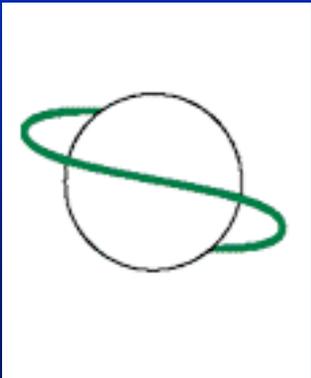
Off-Grid Wind/Diesel/PV Hybrids

Obstacles to Off-Grid Hybrids Penetration

- ✍ Legal and pricing barriers to independent private mini-utility grids
- ✍ Failure by monopoly parastatal utilities to “declare their hand” in terms of timing and coverage service provision to new areas
- ✍ Small project size and hence high relative transactions costs
- ✍ Lack of a track record in developing countries ✍ lack of knowledge of costs and performance

Global Environment Facility

UNDP
UNEP
World Bank



Financial Resources



**\$2.8
billion***

*** over 4 years with about 40-50% for climate change**

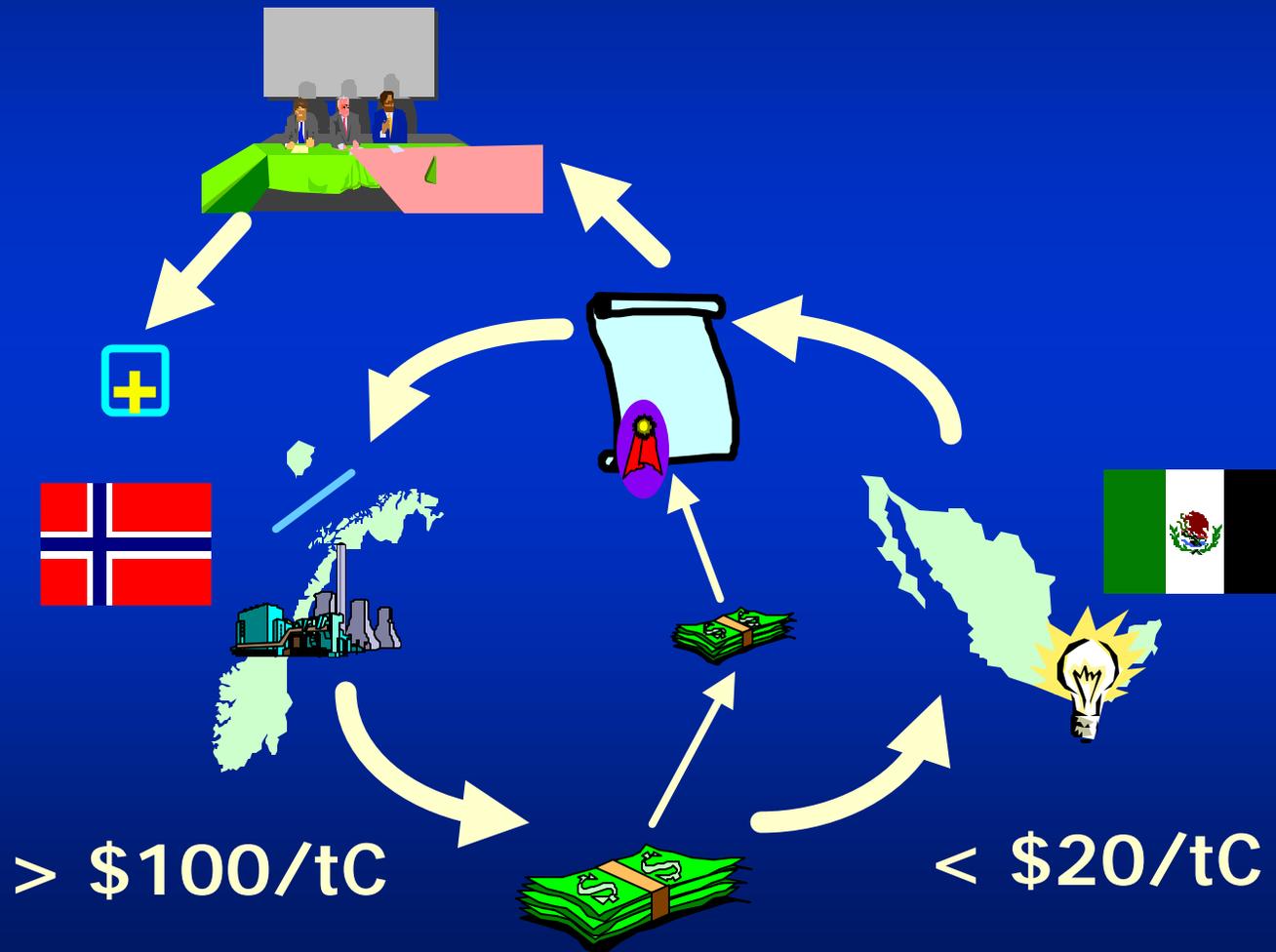
GEF Financing Modalities

- ✍ To eligible *developing countries* (UNFCCC ratifier; WB/UNDP recipient)
- ✍ Provides *incremental cost* financing (i.e., portion not justified in the domestic context) to obtain *global benefits*
- ✍ In response to *government requests* or may grant direct to *private sector* with government approval

GEF Climate Change Strategy - Key Elements

- ✍ Long-term Mitigation Projects
 - Removing Barriers to Energy Conservation and Energy Efficiency
 - Promoting Adoption of Renewable Energy
 - Removing barriers
 - Reducing implementation (transaction) costs
 - Reducing Long-term Costs of Low GHG Emitting Technologies
 - Moving down the tech. learning curve

Kyoto Protocol Mechanisms



Marginal Costs of Abatement (\$/tonne carbon)

<u>Scenario</u>	MIT (2010, <u>1985\$</u>)	PNL (2010, <u>1992\$</u>)
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Global Trading	\$24	\$26

